Renewable and Sustainable Energy Reviews 13 (2009) 1096–1103

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Financing rural renewable energy: A comparison between China and India

Huang Liming *

Institute of South Asian Studies, National University of Singapore, 469A Bukit Timah Road, #07-01 Tower Block, 259770 Singapore, Singapore

ARTICLE INFO

Article history:
Received 29 February 2008
Accepted 24 March 2008

Keywords:
Financing
Rural Renewable energy
China
India

ABSTRACT

This paper analyses the current status of rural renewable energy (RRE) in China and India, develops and employs an analysis framework to study the environment, channels, instruments and innovative mechanisms of financing rural renewable energy in China and India, and makes a primary comparison.

Contents

1. Introduction . . . 1097
2. The current status of rural renewable energy in China and India . . . 1098
3. The financing for rural renewable energy in China and India . . . 1098
   3.1. Financing environment for rural renewable energy . . . 1099
      3.1.1. China's financing environment . . . 1099
      3.1.2. India's financing environment. . . . 1099
   3.2. Financing channels for rural renewable energy . . . 1100
      3.2.1. Government finance . . . 1100
      3.2.2. International funding. . . . 1100
      3.2.3. Commercial banks and non-bank financing institutions . . . 1101
      3.2.4. Public stock markets . . . 1101
      3.2.5. Private sector finance . . . 1101
   3.3. Financing instruments for rural renewable energy. . . . 1101
      3.3.1. Grants. . . . 1101
      3.3.2. Renewable energy service companies (RESCOs). . . . 1101
      3.3.3. Low-interest and long-term loans . . . 1101
      3.3.4. Joint ventures. . . . 1101
      3.3.5. Asset financing. . . . 1101
      3.3.6. Venture capital/private equity . . . 1101
      3.3.7. Subsidies . . . 1101
      3.3.8. Import duty reduction. . . . 1101
      3.3.9. Reduction in value-added tax . . . 1102
   3.4. Innovative financing mechanisms for rural renewable energy . . . 1102
4. A primary comparison of financing rural renewable energy in China and India . . . 1102
5. Conclusion . . . 1102
References . . . 1103

* Tel.: +65 6516 3147; fax: +65 6776 7505.
E-mail address: thlm@jnu.edu.cn.

1364-0321/$ – see front matter
doi:10.1016/j.rser.2008.03.002

1. Introduction

Energy is core component in developing economy, eradicating poverty and improving living standards. It contributes directly to meeting both basic needs and more sophisticated human needs. However, many households, small businesses, and communities in rural areas of both China and India have no access to electric grids or modern cooking fuels. Over 800 million of China's total population of 1.3 billion inhabitants live in rural areas, of which 30 million people still do not have access to electricity [1]. India accounts for a third of the world's population without access to electricity and about 40% of those without access to modern energy [2]. Of the 87 million rural households, not more than 30% have access to electricity [3]. In practice, most of the so-called electrified villages do not have reliable, regular, adequate, or good quality power [4]. Villagers rely on kerosene for lighting and biomass fuels (often burnt in inefficient stoves) such as wood, animal dung and agricultural residues for cooking [5]. Lack of energy is among the key retarding forces preventing economic development and consequently slowing down poverty alleviation and growth of the rural sector. And the impact that lack of access to modern energy has on economic and social development and the lives of poor people is increasingly recognized by China's and India's government. Both countries give rural electrification of high priority: to meet its economic, social, political and regional development goals. In China, electrification in rural areas is listed in the 9th, 10th and 11th Five-Year Plan as one of key areas for development in those plans. India is also seeking to provide rural electrification solutions as evidenced by the Ministry of Power Accelerated Rural Electrification Program, which targets 100,000 villages [6]. The problem is how to expend energy coverage to rural areas. Although traditional strategies such as fossil fuels-based grid extension are expending coverage, and must continue to be a major part of the energy access equation in two countries, China and India still face some serious problems. These are: (1) shortage of fossil fuels. The two countries already rank among the world's top fifth energy consumers with astonishing economic growth rates nearing 10% per year [7]. China's growth rate of the consumption of energy has increased 4.3% per year since 1980 and India's has been 5.4% [8]. In 2006, China's total energy consumption was 2.46 billion tonnes of standard coal equivalent [9]. India consumes about 4% of the world's total energy per year [7]. According to the IEA, overall demand for energy in China and India is projected to approximately double by 2030. The International Energy Agency in Paris forecasts that two-thirds of all future energy demand will emanate from just the two countries. China and India have rich coal resources (China is the number one coal producer, and India has the fourth largest coal reserves in the world), but most of the coal is mainly burned directly with low efficiency. Both nations have thus oil and gas plays a comparatively important role in their national economic and social development. China's oil demand has been growing at an average 7% since 1990 [10], and while it's now the world's second largest consumer of oil after the United States. Chinese demand for oil is expected to more than double from 7.1 million barrels a day in 2006 to 16.5 million barrels by 2030 [11]. Oil comprises 36% of Indian primary energy consumption in 2005, and is expected to grow from 119 million tonnes oil equivalent (MTOE), from 2004, to 250 MTOE, during 2025, at an annual growth of 3.6% [12]. However, their domestic oil cannot meet the need of economic and social development. China imports 50% of its oil consumption [13] and India imports more than 70% [14]. Although the two nations are two Asian giants that consume only a third as much oil as the US today, by 2030 China and India together will import as much oil as the US and Japan do today. Their combined oil imports will rise from 5.4 million barrels per day in 2006 to 19.1 million bpd in 2030 [15]; (2) environmental constrains. As their consumption of fossil fuels accelerates, so will India's and China's emissions of greenhouse gases such as carbon dioxide. Although today they contribute only 4% and 14%, respectively, to total global carbon dioxide emissions [8], emitting just 10% as much greenhouse gas per capita as North America, India's and China's emissions are rising far faster [16]. These figures are projected to increase to 5% and 18% by 2025. This represents a 3.3% annual average percentage increase by China over the next 20 years, and a 2.9% increase for India [8]; (3) higher cost. The grid extension is often more expensive in rural areas than in urban areas because of its lower load densities, low capacity utilization rates, high electricity line losses, and requirement for accompanying infrastructure development such as road building. Extending the lines to rural areas therefore would only increase the costs of the overall generated electricity. A 2000 World Bank/UNDP study on rural electrification programmes placed the average cost of grid extension per km at between $8000 and 10,000, rising to around $22,000 in difficult terrains. Extending the electric grid to remote and low-density rural areas can cost seven times more than providing electricity in an urban area [17].

How to solve the above problems? It is obvious that with such limited energy resources, it is difficult to meet the energy demands of urban areas and industries, let alone solving energy problem in rural area with fossil fuels [18]. In fact, the centralized utility model is not always the most effective channel to deliver new energy services to those currently without access [19]. With the advent of mature renewable energy technologies, the supply of power to remote rural areas from the centralised grid is becoming less competitive, as well as being more harmful to the environment and requiring more extensive infrastructure [4]. For instance, the price of generating electricity through SPV has fallen 60% between 1990 and 2007. The efficiency of SPV cells has also gone up many times, from five percent in 1954 when the first cell was developed to 24% now. The cost of generating electricity through SPV had fallen from $300 per watt in 1954 to $4.5 per watt now [20]. Although not all renewable technologies are yet cost competitive in many applications, in many rural applications off the existing transmission grid, it is more cost effective to install a dispersed renewable energy technology to provide electricity than it is to extend the transmission grid to the region so as to supply centrally generated electricity. In particular, new forms of energy production that can provide stand-alone power, operated by small and medium-sized enterprises, may bring down this cost. There is increasing recognition of the need for small rather than big power stations to meet power demands in particular locations, e.g. in remote areas and on islands [21]. Renewable energy sources also lend themselves to smaller power stations. Small-scale power generation offers environmentally sound ways to produce energy for local use from locally available materials.

In order to solve the problem of electricity supply in rural areas of China and India, local renewable sources of energy are becoming a more attractive alternative. The problem is how to enhance the development of rural renewable energy in China and India. Many studies show that the development of rural renewable energy depends on a variety of socio-techno-economic-institutional factors, but the financing is a key ingredient. However, up to now some main issues of the financing for rural renewable energy in China and India have not been adequately explored and/or sought after. Therefore, it is necessary to conduct research related to the financing rural renewable energy in China and India.

In this study an analysis framework for financing rural renewable energy is developed. In this analysis framework, (1) many complicated issues of financing rural renewable energy in China and India are classified as four types, including the environment, channels, instruments and innovative mechanisms of financing rural renewable energy; (2) financing environment is

Table 1
Leading countries in rural renewable energy systems 2005 [27]

	1	2	3	4	5
Village power small hydro, wind, PV, biomass	China	India	Nepal	Vietnam	Sri Lanka
Water pumping mechanical wind, PV	Argentina	China	South Africa	Namibia	India
Solar home systems	India	China	Thailand	Kenya	Sri Lanka
Biogas	China	India	Nepal		
Biomass gasification	India	China			

Source: REN21:Global Status Reports.

defined as regulatory, legislative and policy conditions; (3) financing channel is defined as the source of financing; (4) financing instrument is defined as the specific delivering method of financing.

The remaining sections of paper are presented as follows: Section 2 analyses the current status of rural renewable energy in India and China. Section 3 develops and employs an analysis framework to study the environment, channels, instruments and innovative mechanisms of financing rural renewable energy in India and China. Section 4 makes a primary comparison of financing rural renewable energy in China and India. Final section remarks conclusions.

2. The current status of rural renewable energy in China and India

Both China and India recognize the importance of expanding access to modern energy services for rural areas of their countries through the development for renewable energy. They already are two world's leading countries in rural renewable energy systems (see Table 1). China has an impressive history of use of renewable energy for rural development, with some of the world's rural largest programs on small hydro, biomass, wind, PV and biogas. At the end of 2006, the installed capacity for small hydro in China has been 50,000 MW. China has over 200,000 stand-alone wind turbines, located in rural areas, with total installed capacity of 30 MW. At present, there are over 20 domestic wind turbine generator manufacturers in China [22]. By end of 2005, China's installed capacity of PV systems in over 70 MW, of which about 50% is used to supply electricity to the residents of remote rural areas, a market that is growing at 20% annually. By the end of 2006, geothermal pump generation has been developed in many provinces of China except Qinghai, Yunnan, and Guizhou. The total national installed systems so far have exceeded 30 million square meters in construction areas. According to a partial statistics, the total geothermal pump sales have exceeded 100 million yuan and are increasing 20% each year [23]. At the end of 2006, the installed capacity for small hydro in China has been 50,000 MW, with annual power generation over 150 TW h, which account for 39% and 36% of the total installed hydropower capacity and annual hydroelectric generation of China, respectively [24]. In recent years, about 2 million household biogas digesters have been newly built every year. By the end of 2005, 18 million households have adopted biogas technologies, annually producing biogas 7 billion m^3 and there are 3556 biogas plants, treating animal wastes 87 million tonnes [19].

In India, over 3000 remote and inaccessible villages and hamlets have been provided with basic electricity services through distributed renewable power systems. India is the largest producer of world's rural solar home systems and biomass Gasification. India's installed capacity for small hydro has been 1850 MW up to 30 September 2006. Rural applications of solar PV had increased to 340,000 home lighting systems, 540,000 solar lanterns, and 7000 solar-power water pumps. There were 600,000 solar cookers in use. India also has achieved 70 MW of small-scale biomass gasification systems for rural (off-grid) power generation [25]. Currently, biomass helps to meet 70% of the basic energy needs of the rural areas almost covering 70% of the population in India [26]. About 100,000 biogas plants and 16,530 solar photovoltaic lighting systems were installed during 2004–2005. Biomass power projects aggregating to 140 MW capacity were installed, which have created large number of employment and income generation opportunities, especially in rural areas. In addition, 100% producer gas operated engine was developed and deployed in several villages for rural electrification. Over 150,000 square meters of collector area has been installed in the country for solar water heating in domestic, industrial and commercial sectors making the cumulative installed collector area over one million square meters.

3. The financing for rural renewable energy in China and India

Both China and India have long been recognized the potential for renewable energy technologies (RETs) as environment-friendly, versatile and sustainable energy alternatives for rural areas and have made great progress in renewable energy in rural electrification, but RETs have not yet succeeded as a major alternative source of energy in rural areas of the two countries. In addition, many households, small businesses, and communities in rural areas of both China and India still have no access to electric grids or modern cooking fuels. Therefore, there is need for speeding up the development for rural renewable energy so as to expend energy coverage to rural areas. China plans to electrify 10,000 villages and 3.5 million rural households with renewables by 2010. India has recently proposed to augment cooking, lighting, and motive power with renewables in 600,000 villages by 2032, starting with 10,000 remote un-electrified villages by 2012 [28]. The Indian Government has assigned the Ministry for Non-conventional Energy Sources to electrify 25,000 rural Indian villages based on renewable energy as part of the major rural electrification programme [29]. How to speed up the development of rural renewable energy and to achieve the above goals? Many studies indicate that the development of rural renewable energy depends on a variety of socio-techno-economic-institutional factors, but the financing is a key ingredient. The development of rural renewable energy can be speeded up by providing appropriate financial incentives, subsidies, strengthening of the supporting infrastructure to ensure reliability, quality and efficiency. However, up to now some main issues of the financing for rural renewable energy in China and India have not been adequately explored and/or sought after.

In this study an analysis framework for financing rural renewable energy is developed. In this analysis framework, (1) many complicated issues of financing rural renewable energy in China and India are classified as four types, including the environment, channels, instruments and innovative mechanisms of financing rural renewable energy; (2) financing environment is defined as regulatory, legislative and policy conditions; (3) financing channel is defined as the source of financing; (4) financing instrument is defined as specific delivering method of

financing. The following section of this paper employs this framework to systematize the issues of the environment, channels, instruments and innovative mechanisms of financing rural renewable energy in China and India.

3.1. Financing environment for rural renewable energy

The favorable regulatory, legislative and policy conditions are critical for financing rural renewable energy. These conditions strongly affect the possibilities and competitiveness of RE, sometimes in a way that economically viable rural renewable energy projects are financially not viable.

3.1.1. China's financing environment

China's government started to pay attention to renewable energy development in rural areas and realized the importance of providing the required regulatory, legislative and policy support for the financing for rural renewable energy in 1970s.

(1) In 1973 the Chinese government promulgated the Agricultural Law. In the provision 57 it clearly states that agricultural and rural economy development must utilize and protect natural resources such as land, water, forest, grassland and wild life in a sustainable way, renewable energy and clean energy such as hydraulic energy, biogas, solar energy and wind energy should be utilized and developed in a sustainable way. It is encouraged to develop ecological agriculture and to protect and improve ecological environment.
(2) The 1995 Electric Power Act, the first Chinese law that discuses energy policy, stresses that China wants to develop water resources in rural areas and promote small hydropower systems for rural electrification. The deployment of solar energy, wind, geothermal, biomass, and other renewable energy resources will be encouraged and supported by the government.
(3) In 1996 the Ministry of Electric Power (MOEP) issued the "Parallel Operation Regulations for Wind Power Generation". It requires that the power grids must allow interconnection and parallel operations of wind farms, and that the power grids must buy all the electricity generated by the wind farms. It further specifies that the purchase price should include production cost, repayment of debt and interests, taxes, and a reasonable profit. The difference in prices between the wind energy and the average market price should be borne by all the customers of the power grid, not just the customers closest to the renewable energy projects.
(4) The 1998 Energy Conservation Act again recognizes and emphasizes the importance and strategic role of using renewable energy to reduce emissions and to protect the environment.
(5) In 1999, State Planning Commission, through the State Council, approved regulations to support the development of renewable energy and to accelerate the local production of the power equipment.
(6) The middle-term and long-term development policies have all emphasized that rural electric development will be a critical task of China's energy development, the development strategies should adapt to local conditions, and the importance of small hydro, wind, solar energy, geothermal, and biomass resources. Long-term development policies are mainly reflected in "China Agenda 21" and "Long Term Objectives on Economic and Social Development of China", especially "Outline for Development of the New and Renewable Energy in China (1996–2010)". The 6th, 7th, 8th, 9th, 10th and 11th "Five-Year Plans" listed middle-term policies of renewable energy development in China during the different periods.
(7) Strategic planning for renewable energy development in 2020 Part way through 2003, the National Development and Reform Commission (NDRC) initiated the formulation of Strategic planning for renewable energy development in 2020, to promote renewable energy technology development in China and keep up with world trends. The strategy is based on renewable energy resources and technology characteristics in China to meet the social and economic development requirement, and it draws on foreign experience and lessons learned. The strategy presents the objectives, layout and policy measures for renewable energy development in China in the next 20 years, guiding the path of development and construction of key projects in the renewable energy field.
(8) Renewable energy law, which came into effect in January 2006, defines renewable energy to include hydroelectricity, wind power, solar energy, biomass energy, geothermal energy and marine energy. The law aims to boost China's renewable energy capacity to 15% by the year 2020 and outlines a commitment to invest $180 billion in renewable energy over this period. It sets the stage for the widespread development of renewable energy in China, particularly for commercial-scale electricity generation facilities. It stipulates that the development and use of renewable sources are an area of priority for future energy development and requires grid operators to purchase resources from renewable energy producers, and offers financial incentives to foster renewable energy development, including discounted lending and a range of tax breaks. Through this legislation, the state officially encourages the construction of renewable energy power facilities. China's electricity grid is obligated to purchase all the electricity generated by approved renewable energy facilities located in its service area. The grid's buying price for renewable energy is set by the National Development and Reform Commission (NDRC), a regulatory department of the State Council. NDRC will adjust the buying price from time to time as necessary. The cost of purchasing this power will be spread amongst the customers on the whole country grid. The law includes other details related to the purchase and use of solar photovoltaics (PV), solar water heating and renewable energy fuels. Finally, the law includes specific penalties for non-compliance.
(9) The Ministry of Finance in China promulgated "Interim measures for the administration of special funds for the development of renewable energy", which took effects on 30th May 2006. The new interim measures for the administration of special fund for the development of renewable energy define the scope and principles of the policy as well as focus on specific steps the government is taking to finance renewable energy development. This will be conducive to increasing government investment in renewable energy, better introducing social investment and bank funds into the sector, and promoting the development of renewable energy. It is in precisely this situation that the Chinese government has defined the goals of this special fund and financial management policy: scientific and technological research and development; use of renewable energy resources in remote agricultural and livestock areas; exploration of resources; equipment manufacturing and more. Support will be given to key projects involving the development of alternatives to oil, such as solar energy, geothermal energy, wind energy and ocean energy.

3.1.2. India's financing environment

The importance of the increasing need to provide renewable energy sources was recognized by India's government in the early 1970s. For nearly 40 years, Indian significant efforts have gone into

the design, development, field demonstration and large-scale use of a number of renewable energy products and systems.

(1) In 1981, the Government of India established a Commission for Additional Sources of Energy (CASE) in the Department of Science and Technology, on the lines of the Space and Atomic Energy Commissions. CASE was charged with the responsibility of formulating policies and their implementation, programmes for development of new and renewable energy apart from coordinating and intensifying R&D in the sector.
(2) In 1982, CASE was incorporated in the newly created Department of Non-Conventional Energy Sources (DNES), which in 1992 became the Ministry of Non-Conventional Energy Sources (MNES) and was renamed as Ministry of New and Renewable Energy (MNRE) in 2006. India is the only country in the world that has an exclusive ministry which deals with new and renewable energy sources. MNRE supports the implementation of a large broad-spectrum of programmes covering the entire range of new and renewable energies. The programme broadly seeks to, inter-alia, supplement conventional fossil fuel-based power; reach renewable energy, including electricity to remote rural areas for a variety of applications like water pumping for irrigation and drinking water purposes, drying farm produce, improved chulhas and biogas plants, energy recovery from the urban, municipal and industrial wastes. In addition, exploitation of hydrogen energy, geothermal energy, tidal energy and biofuels for power generation and automotive applications is also envisaged.
(3) The 9th, 10th and 11th Five-Year Plan all clearly indicate that rural development and energy are major goals for the plan periods. Use of non-conventional energy is specifically mentioned. The various programmes of the MNRE (MNES) are expected to be strengthened and it is expected that there will be increased emphasis on renewable energy using locally available resources. To this end decentralized energy planning through IREP will continue and the various MNRE (MNES) technology initiatives (biogas, biomass, solar, wind, etc.) will also continue.
(4) In 2003, India's government enacted the Electricity Act. The Act is the most important legislative development which has stimulated the recent growth in renewable power in India. The Act recognizes the role of renewable energy technologies for supplying power to the utility grid as well as in stand alone systems. The Act 2003 has several provisions favorable to RE power, including rural electrification. It provides for local generation and distribution of electricity by panchayats (legally elected village level governing body), rural franchisees, NGOs and user associations by involving local communities in managing electricity distribution. Under the proposed open access scheme, the independent power producers (IPP) can set-up RE power plants for captive use, third party sale, power trading companies and for their own transmission and distribution both in rural and urban areas. The act also directs the central government to prepare national electricity and tariff policies, including RE-based power, and currently MNES is in the process of developing the same for RE. The most important feature and the highlight of the act is that it empowers the state electricity regulators to promote RE and specify for purchase of electricity from RE sources, a percentage of the total consumption of electricity in the area of the distribution licensee. This is considered as a major boost for the promotion of the RE sector in India. In other words, once it is implemented, the utilities in the state will have a target of procuring RE-based power based upon a certain percentage as specified by the regulator. In this liberalised electricity market, the financing mix for RE is likely to change as new financing institutions and mechanisms are expected to enter [30]. The act also has several provisions favorable for renewable power, including rural electrification. Its most important feature, however, is to stipulate that distribution companies must buy part of their electricity purchases from renewable sources. This is considered a major boost for renewable energy promotion in India [31].

3.2. Financing channels for rural renewable energy

The financing channels of rural renewable energy of China and India mainly include government finance, international funding, commercial banks and non-bank financial institutions, public stock markets and private sector finance.

3.2.1. Government finance

Financing rural renewable energy is a part of financing rural electrification. Financing rural renewable energy is different from financing renewable energy on the bulk power market. It is an issue of improving social equity, rather than an issue of correcting for market imperfections. The government finance is the most important channel for financing rural renewable energy. The governments of both China and India have a strong role to play in financing rural renewable energy by initiating national programme and providing financial incentives. In late 2001, China's State Development and Planning Commission (renamed the National Development and Reform Commission [NDRC] in 2003) launched an ambitious renewable energy-based rural electrification program known as Song Dian Dao Xiang, literally "Sending Electricity to Townships". The program electrified more than 1000 townships in nine western provinces – Xinjiang, Qinghai, Gansu, Inner Mongolia, Shaanxi, Sichuan, Hunan, Yunnan, and Tibet – bringing power to nearly 1 million people and providing the basis for rural economic development. Installation was completed in June 2003 and consisted of 20 MW from PV, 840 kW from wind, and 200 MW from small hydropower (in Hunan and Yunnan provinces). The government provided 240 million U.S. dollars (USD), or 2 billion Chinese yuan (CNY), to subsidize the capital costs of equipment. The Chinese Township Electrification Program is the first nationally based implementation of renewable technologies to supply electric service to rural populations and also is one of the largest renewable energy-based rural electrification programs in the world, and it has enough critical mass to create a truly robust and sustainable renewable energy infrastructure in China, especially for PV. The program represents an important launch point, as the lessons learned will have an immediate impact not only on future objectives of rural electrification, but also ostensibly on renewable energy programs worldwide. Similarly, India's Integrated Rural Energy Program using renewable energy had served 300 districts and 2,200 villages by early 2006. More than 250 remote villages in seven states were electrified under the program during 2005, with additional projects under implementation in over 800 villages and 700 hamlets in 13 states and federal territories.

3.2.2. International funding

In China and India international financing sources have played a major role as incubation funds for the development of rural renewable energy. Many rural renewable energy projects in China and India have been financed by Multilateral and bilateral organizations. In China the financed projects by international funding mainly include: "Capacity building for the rapid commercialization of renewable energy", "China renewable energy development project", "the solar village project", "wind power project in China's Hubei", "clean energy research project", "the Brightness Program" and "CERUPT: Inner Mongolia Huitengxile

wind power project". In India the financed projects by international funding mainly include: "Optimizing development of small hydel resources in hilly areas", "Indian hybrid energy project—world renewable spiritual trust", "India renewable resources development project", "Second renewable energy project", "India renewable energy development project" and "The Commercializing Renewable Energy in India" [32].

3.2.3. Commercial banks and non-bank financing institutions

Internal financing in both China and India will be a significant source of financing. The two countries both have a well-developed rural banking infrastructure, but the links to the renewable energy sector are weak at best. In both countries traditional banking systems are still not active in financing rural renewable energy in view of the high risk and low profit associated with these loans. Financial institutions are not always interested in giving or opening lines of credit for rural renewable energy.

3.2.4. Public stock markets

In China and India public stock markets have opened to renewable energy. In India many Indian RE companies have chosen to go public on Indian stock exchanges [33]. In China the 23 RE enterprises have been listed on the Shanghai and Shenzhen Stock Exchanges.

3.2.5. Private sector finance

China's private sector finance for rural renewable energy, especially for rural small hydropower (SHP) has grown fast. For example, during 1994–2002 private investment in new SHP in Zhejiang Province amounted to US$1 billion, accounting for more than 70% of the total. In Jingning county of Zhejiang, US$105,562,300 was accumulated from private enterprises for setting up 91 SHP stations with a total capacity of 155.4 MW since 1990. In Guangdong, private investment was over a half of the total SHP investment of US$839,178,000 during the "9th Five-Year Plan" period. In 1999 the Indian central government announced a policy of opening electricity generation to private participation. To help the private sector create market for renewable energy, IREDA took a number of measures to raise awareness among investors and banking institutions of the viability of renewable energy technologies and overcome the barriers of access to market for renewables.

3.3. Financing instruments for rural renewable energy

In both China and India a number of financing instruments have been used to facilitate financing of rural renewable energy. An overview of the existing financing instruments to help promote investments in the development for rural renewable energy of the two countries is presented below:

3.3.1. Grants

Declining cash grants on a sliding scale over the life of the project are built into more recent projects to "push" the market early on and then allow a transition to a fully commercial market. Some projects are offered fixed cash grants for each system installed once certification of the installation is available. For example, in the China Renewable Energy Development projects, a $100 cash grant is paid directly the SHS dealer.

3.3.2. Renewable energy service companies (RESCOs)

The RESCO concept is most suitable for small-scale renewable energy systems like PV solar home systems (SHS). Rather than sell SHS to homeowners, the RESCO sell the service that is produced by the SHS and in turn collect a monthly fee. The RESCO can aggregate a large number of consumers into a single project rather than for each SHS. The consumer overcomes the high cost barrier by having only to make small monthly payments. Dozens of RESCOs have been set up to provide the services of sale and installation and maintenance of household solar PV systems in China and India, and solar water heating in India.

3.3.3. Low-interest and long-term loans

Indian IREDA provides low-interest loans to wind farm developers. Loans are expected to progressively approach commercial market rates as the technologies gains wider acceptance and are considered more transparent and effective at reducing product costs than direct subsidies. The India Hilly Hydel project establishes a revolving fund, also administrated by IREDA, to provide low-interest financing to private entrepreneurs for small hydel projects. Like in the India Alternate Energy project, these loans are expected to progressively approach commercial market rates as the technology gains wider acceptance. The India Hilly Hydel project also creates a national strategy and master plan with detailed investment proposals for additional small hydel projects. Chinese government has established specific low-interest loans for rural energy development since 1987. Interest rate of special low-interest loan for large and medium biogas projects, solar energy applications, and wind technologies is only half of that from a compatible commercial loans. In addition, China also establishes special low-interest loan programs for small hydro projects.

3.3.4. Joint ventures

China has engaged in several successful joint ventures with companies in other countries. For example, the U.S. company Tang Energy Group, Ltd., helped establish ZhongHang (Baoding) Huiteng Windpower Equipment Co., Ltd. in China in 2001. Since then, "Baoding" has captured a dominant share of the Chinese market for blades and nacelle covers for 600–750 kW wind turbine generators. While to date Baoding has sold only to Chinese wind farms, it is preparing to export blades to other Asian wind farms.

3.3.5. Asset financing

China is the third largest location for asset financing for wind projects, after US and Spain. In India asset financing was focused on wind, although the majority of investment is by captive power generators.

3.3.6. Venture capital/private equity

In China Venture capital funding for renewable energy is soaring. Venture capital investment in RETs reached $403 million in 2006. Thirteen of the 17 deals in RETs were in solar, totaling $367.8 million. Wind power accounted for two deals totaling $22 million while there were two deals in biomass amounting to $13.2 million [34]. After the US, China was the second largest recipient of Venture Capital [35]. In 2006, roughly half of the VC/PE total ($100 million) was private equity investment for expanding wind-manufacturing capacity.

3.3.7. Subsidies

In China the main subsidies for rural renewable energy are provided by the central government and the local governments usually to support research, development and demonstration projects for rural renewable energy. In India the subsidies such as interest subsidy and capital subsidy are mainly provided by the Ministry of New and Renewable Energy Sources.

3.3.8. Import duty reduction

In China, the imports of renewable energy technologies used to be exempt from payment of import duty; in India this is the case for renewable energy technologies not produced in India.

3.3.9. Reduction in value-added tax

In China the rate of value-added tax (VAT) is 17%. VAT for biogas, wind power and small hydro is only 3%, 8.5% and 6%, respectively. VAT for power generation from municipal solid waste is 0%. In India, the VAT on renewable energy equipment is lower than the normal rate.

3.4. Innovative financing mechanisms for rural renewable energy

The key issue of financing rural renewable energy in China and India is the availability of capital to renewable energy developers and rural end-users, while issues involve the cost of money, the ease of obtaining low-cost funds, and institutional complexities that hinder financing and market growth. While conventional funding and financial instruments such as capital subsidies, donor grants, and tax rebates and similar fiscal incentives have been able to achieve a certain level of penetration, the large-scale use and commercialization of renewable energy products and technologies requires innovative approaches to the selection and delivery of financial instruments and channels. Many innovative mechanisms for financing renewable energy have been devised and tested by China and India to promote rural renewable energy. These innovative financing mechanisms include the mechanisms that combine government and community financing (India); development of a market-oriented institutional and financial model for decentralised solar systems (India); wind-power development through combination of the Clean Development Mechanism (CDM) and public sector financing (India); scaling-up of renewable village power through governmental finance and bidding based on market regulation (China); experience of the first CDM project in renewable energy financing in China (China); financing the utilization of landfill gas through economic incentives (China); commercialisation of solar hot water systems through a ‘financial intermediary (FI) scheme’ (India); market development for solar lanterns in a post-subsidy regime (India) and developing a sustainable financial model for solar pumping systems (India) [36].

4. A primary comparison of financing rural renewable energy in China and India

(1) Both China and India realize the importance of providing the required regulatory, legislative and policy support for financing rural renewable energy. China has crested a favorable environment for financing rural renewable energy. It is one of 48 countries worldwide that have enacted laws for renewable energy development [37]. There is no a National Renewable Energy legislation in India yet. Even India does not have any Energy Policy today. However, an Expert Committee constituted by the Planning Commission has prepared an Integrated Energy Policy Report (IEPR) covering all sources of energy including renewable energy sources. This report has highlighted the need to maximally develop domestic supply options and diversify energy sources. It has also projected that renewables may account for 5–6% of India’s energy mix by 2031–2032 and has observed that the distributed nature of renewables can provide many socio-economic benefits for the country, including its rural, tribal and remote areas [38].

(2) The demand for the finance of rural renewable energy in both China and India still faces severe constraints on the supply side of their financial systems such as amount of funds, terms and conditions of funds and available financing instruments. Thus the practical relevance of the many financial instruments is rather limited in the commercial financial markets of the two countries for RET financing. However, India has the most complex system of subsidies and financing arrangements for rural renewable energy investments compared to other Asian nations [39]. China does not yet have a fully developed financial incentive system for rural renewable energy, but the government has been providing support for the sector since the 1950s. The major financial incentives in existence today include subsidies, tax-related incentives, custom duties, and pricing incentives, and the government is moving toward more comprehensive quantity- and price-based support mechanisms.

(3) India has created special funding agencies to provide loans for rural renewable energy projects at below-market interest rates. The key institution is IREDA (India Renewable Energy Development Agency), which is the main national provider of finance for RE-projects. Local commercial banks, in turn, are drawn into RE-financing by the example of IREDA. It recently increased its share capital to $226 million, which will allow it to leverage higher levels of private investment. Unlike India, Chinese central government finances rural renewable energy through some different departments. For example, it finances research and development on key renewable energy technologies through the National Development and Reform Commission (NDRC—formerly the State Development and Planning Commission) and the Ministry of Science & Technology (MOST). Funds offered by MOST during the 10th Five-Year Plan period will be 3.4 million USD or 28 million CNY. In addition, there are some subsidies for demonstration projects and training courses from the former SETC, Ministry of Finance (MOF), and Ministry of Agriculture (MOA). The former SETC’s Department of Resource Conservation and Utilization (DORCU) provided low-interest loans, from the state budget to support the development of rural renewable energy. The Ministry of Water Resources (MWR) provides low-interest loans of about 26 million USD or 300 million CNY for small hydropower development [40].

(4) Both China and India are actively expanding their rural renewable energy presence, but much of India’s growth has been financed domestically [33]. In China, however, on the one hand, foreign companies have been active as well as domestic companies. The world’s leading wind equipment suppliers – Vestas, GE Energy and Gamesa – have each set up wholly owned manufacturing facilities in China. And seven foreign development banks, including the International Finance Corporation, Germany’s DEG, and France’s Proparco, have invested in China’s renewable energy projects. On the other hand, Chinese renewables companies are actively seeking the development opportunities beyond their border. For example, six Chinese solar companies have been listed on overseas stock markets. The six listed solar energy companies are Suntech (NYSE: STP), JA Solar (NASDAQ: JASO) Rene Solar (AIM: SOLA), Solarfun Power (NASDAQ: SOLF), Trina Solar (NYSE: TSL), and Canadian Solar (NASDAQ:CSIQ) [41].

(5) Both China and India have devised and tested many innovative mechanisms for financing renewable energy, but the innovative modes of the two nations are different as Section 3.4 describes.

5. Conclusion

In conclusion the comparison of financing rural renewable energy of China and India clearly indicates that there are similar and dissimilar options for financing rural renewable energy between India and China. They are reflected in the environment, channels, instruments and innovative mechanisms of financing rural renewable energy of these two countries, respectively. It’s obviously that the analysis of the similarities and differences between China and India through a comparison of financing rural

renewable energy will be beneficial to promote the experience exchange and technology cooperation in financing rural renewable energy of China and India so as to expend modern energy to rural areas of two countries. More importantly, as two world's leading countries in the development of rural renewable energy, China's and India's experiences in financing rural renewable energy will be of strategic and practical interest to other developing member countries and emerging middle-income countries in the region.

References

[1] Valentine VC. China's Opening to the world: what does it mean for U.S. banks? http://www.fdic.gov/bank/analytical/banking/2005nov/article1.html.
[2] Bhattacharyya SC. Energy access problem of the poor in India: is rural electrification a remedy? Energy Policy 2006;34(18):3387–97.
[3] EREC, European Renewable Energy Export Strategy. http://www.erec-renewables.org/fileadmin/erec_docs/Documents/Publications/DEF_Export_Strategy.pdfN.
[4] Hands On, Series 5: Programme 9 (of 9) - 'A Switch in Time', Plant Power – India, 2005, http://www.handsontv.info/series5/09_ASwitchInTime_reports/report3.html.
[5] Biomass Energy for Rural India (BERI). http://www.undp.org/gef/05/documents/writeups_doc/cc/BERI_CC_notes15jan.doc.
[6] Peter Meisen, Overview of renewable energy potential of India, 2006 http://www.geni.org/globalenergy/library/energytrends/currentusage/renewable/Renewable-Energy-Potential-for-India.pdf.
[7] Balaji Sadasivan. Keynote address at the Institute of South Asian Studies Conference On Geopolitics of Energy In South Asia. 2007, http://app.mfa.gov.sg/2006/lowRes/press/view_press.asp?post_id=2936.
[8] Anthony Wayne E. Energy trends in China and India and their implications for the United States. 2005, http://www.state.gov/e/eeb/rls/rm/2005/66574.htm.
[9] Jiahua Pan. China should prioritize energy efficiency to deal with challenge of reducing emissions. 2007, http://www.worldwatch.org/node/5205.
[10] Matthew Forney, China's quest for oil. TIME; 2004.
[11] Florence Chong. Coal comfort for oil users. 2007.
[12] KPMG. India energy outlook-2007. 2007.
[13] Pepe Escobar. Globalistan: how the globalized world is dissolving into liquid war. Nimble Books LLC. 2007.
[14] Mark Hong. Energy perspectives on Singapore and the Region. Institute of Southeast Asian Studies; 2007.
[15] NewsFeed Researcher. Energy agency urges increase in oil inventories. 2007.
[16] Financing energy efficiency, lessons from recent experience with a focus on Brazil, China and India. May 16, 2006 http://3countryee.org/Reports/IntegratedReportExecSummary.pdf.
[17] FAO. Bioenergy. Committee on Agriculture. 19th Session. April 13–16th, 2005 www.fao.org/docrep/meeting/009/j4313e.htm.
[18] Li Jingming. Rural biogas development in China. http://www.methanetomarkets.org/resources/ag/docs/china_profile.pdf.
[19] Glenn Hodes. A strategy to phase-out lead in African Gasoline, renewable energy for development. Stockholm Environment Institute-Newsletter of the Energy Programme SEI, vol. 16 no. 3 ISSN, 1101-8267. October, 2003.
[20] Solar energy could help light up rural India. Indo Asian News Service; November 05, 2007. http://www.aol.in/news/story/2007110501389012000004/index.html.
[21] Lacey T. From Dr Terry Lacey's desk. ASEANenergy.org; 2004. www.aseanenergy.org/desks/terry_lacey_desk.htm.
[22] Xiao Shu. China's winds of change. China Dialogue, November 08, 2007, http://www.chinadialogue.net/article/show/single/en/1461-China-s-winds-of-change-.
[23] CRESP, Longyuan's Rudong 100 MW State Wind Generation Concession Project Completed Successfully and into Operation. 2007. http://www.cresp.org.cn/english/encontent.asp?id=561.
[24] Zhou Shangjie, Overview of Hydropower Resources and Development in China. 2007, http://www.asiapacificpartnership.org/PowerGenTF/AugustEEV/Chinese.ppt
[25] REN21, Rural (off-grid) renewable energy. http://gsr.ren21.net/index.php?title=5._Rural_(Off-Grid)_Renewable_Energy.
[26] Rajkumar, Biomass power for rural energy and sustainable development in India-role of IREDA, http://www.nri.org/projects/biomass/conference_papers/funding_renewable_energy_programmes_in_india.pdf.
[27] Paul Suding. Renewable energy promotion policy and the international community, Inter-American Development Bank Conference on Investing in Sustainable Energy and Climate Change Mitigation,Washington, 28 and 29 November. 2006.
[28] REN21, Renewables 2007 Global Status Report, http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf.
[29] WWEC. India will electrify 25,000 villages based on renewable energy. Wednesday, September 20, 2006.
[30] Chaurey A, Ranganathan M, Mohanty P. Electricity access for geographically disadvantaged rural communities—technology and policy insights. Energy Policy 2004;32(15):1693–705.
[31] Subramanian V. Renewable energy in India: status and future prospects. 2007.
[32] Liming H. A study of China-India cooperation in renewable energy field, Renewable and Sustainable Energy Reviews 2007;11:1739–57.
[33] Carbon funds now total $11.8 billion. June 21, 2007 http://www.carbonyatra.com/news_detail.php?id=439.
[34] Chen Jialu. Venture capital for green start-ups on the rise. China Daily; 2007. p. 15
[35] Virginia Sonntag-O'Brien, Global investment in 2007 in the sustainable energy market. May 9, 2007.
[36] RISPO. Innovative financing mechanisms for renewable energy development. http://www.iges.or.jp/APEIS/RISPO/p_report_2nd/06_3_2_1_innovative_financing_for_renewable_energy.pdf.
[37] Jianxiang Yang. China speeds up renewable energy development. World Watch. October 26, 2006.
[38] Ministry of New and Renewable Energy. Non-conventional energy and its potential sources. November 28, 2007, http://mnes.nic.in/press-releases/press-release-28112007.pdf.
[39] Steven Ferrey. Small power purchase agreement application for renewable energy development: lessons from five Asian countries. February, 2004, http://siteresources.worldbank.org/INTEAPREGTOPENERGY/Resources/Power-Purchase.pdf.
[40] Renewable energy policy in China: financial incentives, http://www.nrel.gov/docs/fy04osti/36045.pdf.
[41] Big potential risks faced by China's photovoltaic industry - [Alternative Energy], 2007-05-24, http://cutesky.blogbus.com/logs/5492522.html.